on electrolysis of pure water. The fact that an appreciable difference in level can be demonstrated in less than half an hour makes this simple experiment a great success as a lecture demonstration. In addition to the above differential measurement which very convincingly demonstrates the failure of Faraday's law this apparatus is also very suitable by connecting one side of the manometer to the atmosphere for measuring the rate of gas evolution singly in any one of the cells.

Our above observations confirm our previous finding that Faraday's law falls short considerably in the electrolysis of water. Such wide discrepancy is difficult to be explained by assuming side reactions, for example, by assuming H_2O_2 formation at anode and reduction of the same at cathode, as suggested by Page and Lingane (1957) to be responsible for small observed deficit in hydrogen oxygen gas coulometer. It appears that with decrease of ionic concentration and current strength, and increase of voltage, the current tends to be carried by a mechanism different from that envisaged by Faraday's law. As to the mechanism of this non-electrolytic conduction, it is recalled that in some crystals as also in solutions of sodium in liquid ammonia partly ionic and partly electronic conduction simultaneously takes place. In water medium the electronic conduction is more likely to be through the intermediacy of charged water molecules, $H_2O^-_{aq}$ and $H_2O^+_{aq}$, particularly as hydrated electron has been shown to exist during electrolysis of sodium sulphate solution by Walker (1966, 1967). However, we prefer to keep the question of detailed mechanism open until more definite evidence is forthcoming. Detailed results with this apparatus will be published later.

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REFERENCES

Lingane, J. J., 1945, *J. Amer. Chen Soc.*, **67**, 1916.
Page, J. A. and Lingane, J. J., 1957, *Anal. Chem. Acta*, **16**, 175.
Palit, S. R., 1967, *Indian J. Phys.*, **41**, 309.
Walker, D. C., 1966, *Canad. J. Chem*, **44**, 2226.
———, 1967, *Quart. Rev.*, **21**, 83.

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A NOTE ON LONGITUDINAL DISTURBANCES IN A SEMI-INFINITE PIEZOELECTRIC ROD IN A MAGNETIC FIELD

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The piezoelectric problems constitute an important branch of study in view of their applications in ultrasonics and acoustics and these problems have been considered by Sinha (1962, 1963, 1965a, 1965b, 1968a, 1968b) and Das (1967), but these do not take into account the influence of a magnetic field.

The effect of a magnetic field on the disturbances in a piezoelectric material has been, perhaps, studied first by Benes and Soska (1964). The present note is an effort towards to this end and it seeks to investigate the disturbances when a piezoelectric bar is acted upon by a magnetic field. The Laplace transform serves as an important tool for the solution of the problem.

A semi-infinite pezoelectric bar is acted upon by a magnetic field represented by the magnetic induction B in a direction prpendicular to the direction of the bar. To the finite end, taken to be $x = 0$, a time-dependent displacement is applied. Our object is to determine the longitudinal disturbances in the bar that stem from the interplay of mechanical and electromagnetic fields. The fundamental equations are, therefore, given by, vide, Benes and Soska (1964)

$$C_{ijkl} \frac{\partial u_{kl}}{\partial x_j} + \epsilon_{ijk} \left[\rho_{jrs} \left(\frac{\partial u_{rs}}{\partial t} + \frac{\partial u_{rs}}{\partial x_m} \cdot \frac{\partial u_m}{\partial t} \right) + \epsilon_0 k_{jm} \frac{\partial E_m}{\partial t} \right] = \rho \frac{\partial^2 u_i}{\partial t^2} \quad \ldots \quad (1)$$

$$2u_{kl} = \frac{\partial u_k}{\partial x_l} + \frac{\partial u_l}{\partial x_k} \quad \ldots \quad (2)$$

where the notations have their usual meanings as in Benes *et al* (1964). For longitudinal disturbances in the direction along the x-axis, with no electric field, the above equations give

$$C_{22} \frac{\partial^2 u}{\partial x^2} - e_{1,2} B \frac{\partial^2 u}{\partial x \partial t} = \rho \frac{\partial^2 u}{\partial t^2} \quad \ldots \quad (3)$$

The boundary conditions give $u \to 0$ as $x \to \infty$, ... (4)

$$u = P_0 H(t) \text{ at } x = 0 \quad \ldots \quad (5)$$

where P_0 is a constant and $H(t)$ is a step function of force, equal to unity when $t > 0$ and equal to zero when $t < 0$.

To solve the problem, let us use the Laplace transform $\bar{f}(p)$ of a function $f(t)$,[2] of parameter p, given by

$$\bar{f}(p) = \int_0^\infty f(t) e^{-pt} dt \quad (\text{Re}(p) > 0) \quad \ldots \quad (6)$$

Taking the Laplace transform of (3), we have

$$C_{22} \frac{\partial^2 \bar{u}}{\partial x^2} - e_{1,2} B p \frac{\partial \bar{u}}{\partial x} - \rho p^2 \bar{u} = 0.$$

The solution of this equation is given by

$$\bar{u} = C_1 e^{+m_1 x} + C_2 e^{+m_2 x} \qquad \dots (7)$$

where m_1, m_2 are the roots of the equation

$$C_{22} m^2 - e_{1,2}\, p \quad B_m - \rho p^2 = 0 \qquad \dots (8)$$

The conditions (4) and (5), give $\bar{u} \to 0$ as $x \to \infty$ ... (9)

$$\bar{u} = \frac{P_0}{p} \text{ at } x = 0 \qquad \dots (10)$$

Hence (7) yields, on using, (9), $e_1 = 0$

We can write

$$\bar{u} = C_2 e^{-m_2^1 x}$$

$$m^1{}_2 = p\sqrt{e_{1,2}{}^2 B^2 + 4\rho C_{22}} \text{ where}$$

Using (10), we have

$$\frac{P_0}{p} = C_2$$

Therefore,

$$\bar{u} = \frac{P_0}{p} e^{-p\sqrt{e_{1,2}{}^2 B^2 + 4hc_{22}}}$$

Inverting this transform we have

$$u = 0, \quad 0 < t < \sqrt{e_{1,2}{}^2 B^2 + \rho C_{22}}$$

$$= P_0, \quad t > \sqrt{e_{1,2}{}^2 B^2 + \rho C_{22}}$$

which gives the displacement.

REFERENCES

Benes, F. and Soska, F., 1964, *Czech. Jour. Phys.*, **14**, 188

Das, N. C., 1967, *Indian J. Phys.*, **41**, 611.

Sinha, D. K., 1962, *Jour. Accoust. Soc. Amer.*, **34**, 1093.

——————, 1963, *Ind. Jour. Theor. Phys.*, **11**, 93–99.

——————, 1965*a*, *Zeits. Ang. Math. Phys.*, **1** , 411.

——————, 1965*b*, *Proc. Natl. Inst. Scs.*, **31**, 395.

——————, 1968*a*, *Ind. Jour. Pure. Appld. Phys.*, **5**, 611.

——————, 1968*b*, *Czech. Jour. Phys.*, (in Press).